Environmental Management - Grand Junction Office

UMTRA Project

Final Report
2007 Biota Monitoring
Moab, Utah

February 2008

U.S. Department of Energy

Office of Environmental Management

Work Performed by the Technical Assistance Contractor Under DOE Contract No. DE-AC30-07CC60012 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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1.0 Introduction

The Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site (Moab site) is a former uranium-ore processing facility located approximately three miles northwest of the city of Moab in Grand County, Utah. The plant was constructed in 1956 by the Uranium Reduction Company, which operated the mill until 1962, and operations continued under Atlas until 1984. When the processing operations ceased in 1984, the mill had accumulated an estimated 16 million tons of uranium-mill tailings in an unlined impoundment in the floodplain of the Colorado River.

Results of a number of investigations conducted since the early 1970s, including one completed by DOE (DOE 2003), indicate that contaminants have leached from the tailings pile into the ground water. Several site-related contaminants have been identified, but the most pervasive and highest concentration constituent is ammonia. DOE's studies have identified two plumes of ammonia associated with the site, a deep plume beneath the tailings pile and a shallower plume emanating from the toe of the tailings pile to the Colorado River. Ground water from the shallow plume discharges to the Colorado River and, at times, has a localized impact on surface-water quality in riparian habitats. Degradation of surface-water quality is of concern because of potential effects on aquatic species, particularly endangered fish, in the riparian areas. In its final Biological Opinion issued as part of the DOE's Final Environmental Impact Statement (EIS) for the site (DOE 2005), the U.S. Fish and Wildlife Service (USFWS) identified several actions required by DOE to address concerns regarding endangered fish. Biota monitoring is one of those actions.

The Biota Monitoring Plan (DOE 2006) for the Moab site was designed to evaluate potential effects of site-related contamination on endangered fish in the Colorado River, in particular, the Colorado pikeminnow. The purpose of the biota monitoring was to identify habitat areas for the Colorado pikeminnow within the backwaters on the western bank of the Colorado River and to monitor the habitat areas during fluctuating river levels adjacent to the Moab site.

2.0 Background

Suitable habitat for the Colorado pikeminnow is slow-moving, relatively shallow backwaters. The most favorable habitat areas are backwaters that are connected to the river on the downstream end and closed on the upstream end. The most critical factor for a potential habitat is very low flow velocities. Isolated pools of water are not likely to be considered a habitat area; however, if the pools are surrounded by saturated sediment, it is possible that juvenile fish may take refuge in these pools until an increase in river flow. Based on observations from 2006, suitable habitats formed adjacent to the Moab site only when the Colorado River discharge was less than 7,000 cubic feet per second (cfs) (as measured at the Cisco gaging station).

The objectives of the tasks described in this report are to identify, collect, and preserve for subsequent identification any injured, stressed, or dead fish along the banks of the Colorado River adjacent to the site. The purpose is to estimate the collection as a result of site-related contamination. It is anticipated that several years of biota monitoring may be needed to accomplish this because of natural variations in river conditions. Any modifications to these objectives will be made in consultation with USFWS.

The DOE initiated an Interim Action ground-water remediation in the summer of 2003, and the system was expanded several times through 2006. The Interim Action well field consists of four configurations, or sets of remediation wells. Configuration 4 is the southernmost set, followed northward by Configurations 1, 2, and 3, an infiltration trench, and a baseline well. The Interim Action has a dual purpose: (1) to pump contaminated ground water from configurations of extraction wells in the shallow contamination plume to an evaporation pond and sprinkler system on top of the tailings pile, and (2) to inject diverted Colorado River water into the alluvial aquifer. Item 2 is accomplished by injecting filtered water through a 160-foot-long infiltration trench located on the north end of the well field. In addition, remediation wells in Configurations 2, 3, and 4 are also capable of ground-water injection, but were exclusively extracting ground water throughout 2007. In its final EIS for remediation of the Moab site (DOE 2005), DOE proposed to intercept ground water and control discharge of contaminants to the river until concentrations in the alluvial system are reduced to levels that permit unrestricted discharge. This proposed action could involve scaling up of the existing Interim Action system or augmenting it in some other way.

The configuration of the backwater channel varies from year to year. During the 2006 monitoring season, one main backwater channel flowed from Configuration 3 to Configuration 4. As river flow decreased, portions of the channel were shut-off on the upstream or downstream side or sometimes both. In 2007, the backwater channel flowed more consistently through Configurations 1 and 4, or the southernmost portion adjacent to the Interim Action well field. The backwater-channel locations in this report are referred to in relation to the adjacent configuration of the Interim Action well field. For instance, the Configuration 2 backwater channel refers to the portion of the backwater channel east of Configuration 2 (see Figure 1 Map of Channel Locations).

3.0 Activities

The 2007 Biota Monitoring Season was accomplished through a series of backwater channel observations, collection of surface water samples, and measurement of field parameters. Monitoring began on June 28, 2007 when the Colorado River flow dropped to below 7,000 cfs (based on the USGS Cisco Gaging Station) and continued through September 2007. The monitoring frequency was determined by the river flow. The backwater channels were monitored less frequently when the river flow remained static for a certain length of time, and more frequently when the river flow was more dynamic.

During the monitoring, photographs were taken of various portions of the backwater channel (Attachment 1) in order to compare how the configuration changed with varying flow conditions. Characteristics, such as channel morphology, presence or absence of fish, algal growth, desiccation cracks, and wood debris were recorded. Field parameters were measured and recorded using an YSI 600XL Multi-Parameter Water Quality Monitor. These field parameters include temperature (ºC), conductivity (µmhos/cm), pH (S.U.), dissolved oxygen (mg/L), and oxidation-reduction potential (mV) (Attachment A).

Surface water samples were collected during the monthly sampling events in June, July, August, and September 2007 (see Table 1). These samples were collected from both habitat and non-habitat areas and were analyzed for uranium, total dissolved solids, bromide, chloride,

sulfate, ammonia, selenium, manganese, and copper. See Table 1 for a complete listing of the sampling events, river flows, and locations sampled during the 2007 Biota Monitoring Event.

Table 1. 2007 Biota Monitoring Sampling Event Summary

Event	Date Range	River Flow Range (cfs)	Locations Sampled
June 2007 Monthly	06/12/07-06/19/07	8,700-11,100	CF 1- 0216 CF 2- 0236, 0240 CF 4- 0274
July 2007 Monthly	07/11/07 -07/12/07	3,780-3,880	CF 1- 0216 CF 4- 0274
August 2007 Monthly*	09/04/07-09/12/07	3,300-3,690	CF 4- 274
September 2007 Monthly	09/24/07-09/26/07	6,210-8,100	CF 1- 0216 CF 4- 0274

Notes : * August 2007 Monthly Sampling Event surface water samples were collected in early September. Location 0274 was sampled three times, due to transition from suitable to non-suitable habitat. CF = Configuration, cfs= cubic feet per second

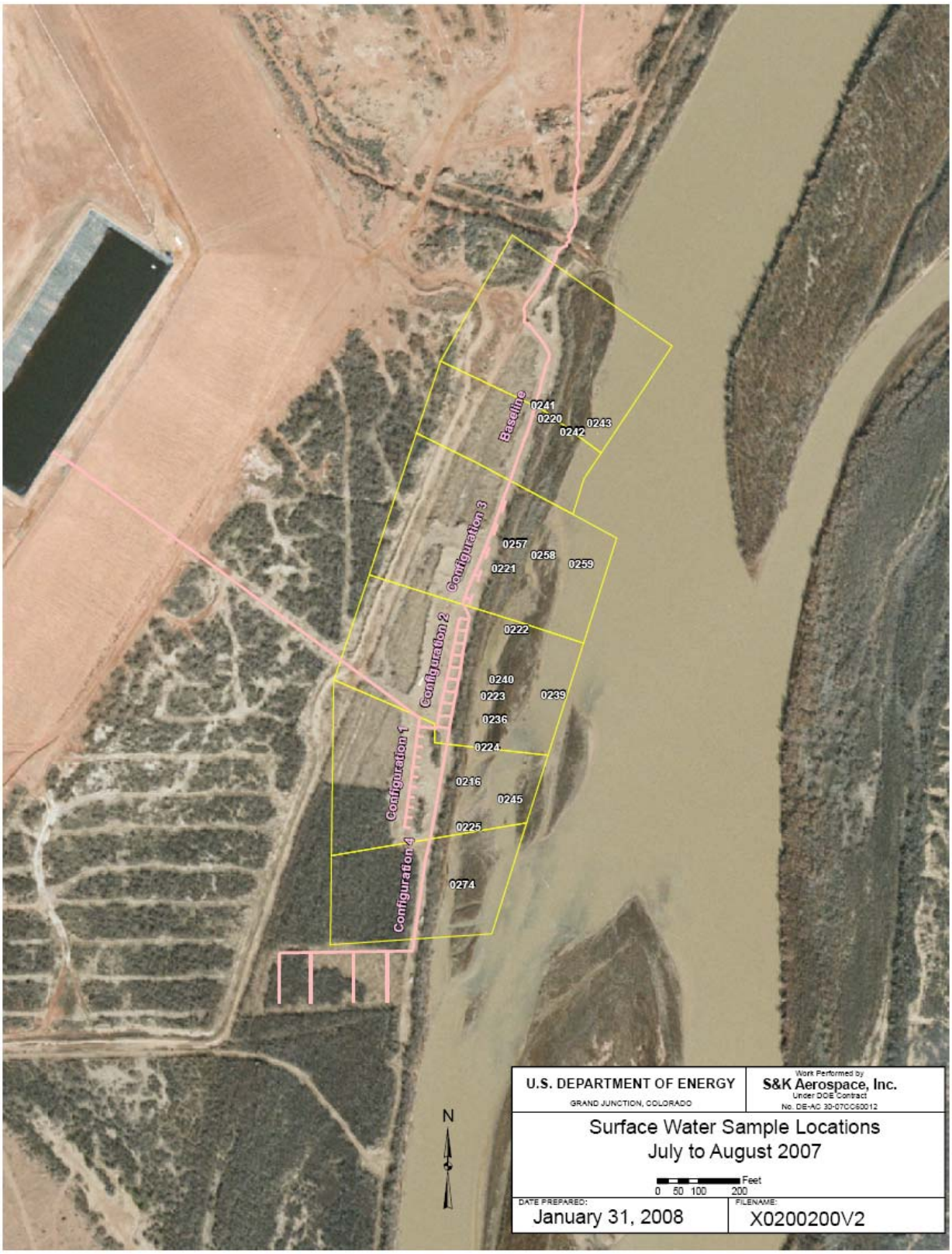

Figure 1. Map of Channel Locations

4.0 Results

4.1 June 2007

The Colorado River flow along the Moab site varied from 6,130 to 11,100 cfs (see Figure 2) during June 2007. The June monthly sampling event took place from June 4 through 19, and the site-wide routine sampling event was conducted June 13 and14. During these events, the river flow varied between 7,970 and 11,100 cfs, which is too high for the formation of suitable backwater habitats for the Colorado pikeminnow. Sample results from early to mid-June indicate that the ammonia levels in the surface water were less than or equal to the 0.1 milligrams per liter (mg/L), whixh was the detection limit.

Biota monitoring commenced on June 28, 2007, when the river flow dropped to 6,790 cfs (see Photos 1 through 6). At this time, the main backwater channel that flows from Configuration 3 through Configuration 4 was connected to the main river channel both in up and downstream directions. In the vicinity of Configuration 3, the channel was barely connected upriver by a few inches of water; therefore, this portion of the channel was considered a habitat area (see Photo 2). Abundant wood debris, algal growth, and isolated deep-water pockets containing small fish (1 to 2 centimeters (cm)) were observed.

The main backwater channel was broad and shallow adjacent to Configuration 2, and numerous schools of fish (1 to 3 cm) were observed (see Photos 3 and 4). Adjacent to Configurations 1 and 4, the main backwater channel had a higher flow velocity and was connected to the main river channel both up and downriver (see Photos 5 and 6). A few fish were observed in this portion of the channel.

During the month of June, the main backwater channel was not considered a habitat area because it was open up and downriver to the main river channel. However, when the Colorado River flow dropped to below 6,790 cfs, the backwater channel adjacent to Configurations 2 and 3 became a habitat.

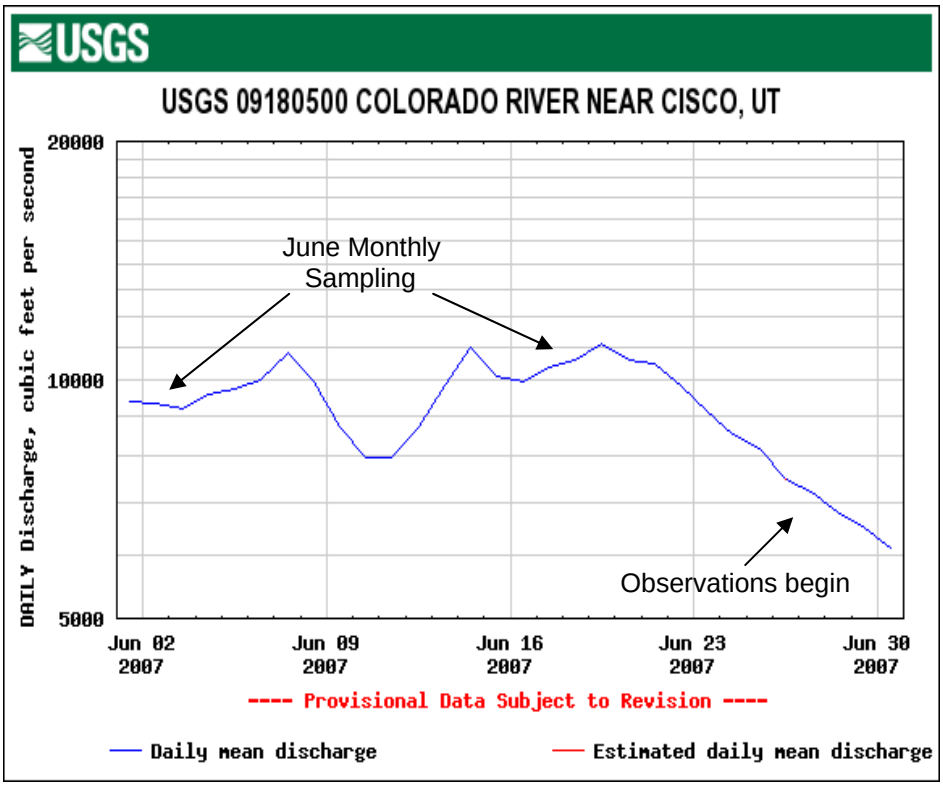

Figure 2. Colorado River Flow (Cisco Gaging Station) During June 2007

4.2 July 2007

On July 3, the Colorado River flow near the site had dropped to 5,150 cfs (see Photos 7 through 10 and Figure 3). At this time, the backwater channel adjacent to Configurations 3 and 2 was closed off from the river and consisted of isolated pockets of water. The southern most portion of the Configuration 2 backwater channel was connected to the Configuration 1 portion of the channel by a temporary channel one to two inches deep (see Photo 10). No fish were observed in the backwaters adjacent to Configuration 2.

From early to mid-July, the backwaters adjacent to Configurations 1 and 4 were connected to the main river channel both up and downriver. Surface water samples were collected from the backwater channel along Configurations 1 and 4 on July 11 and 12, during the July monthly sampling event. The sample analyses show that the concentrations of ammonia (0.27 mg/L at location 0216 and 0.19 mg/L at location 0274) and other constituents increased since the higher river flow in June. Refer to Attachment A for parameters and analyte concentration of surface-water locations during the biota-monitoring event.

During the contract transition from July to early August 2007, biota-monitoring observations were not recorded. During that time, the Colorado River flow near the site ranged from 2,870 to 4,410 cfs (see Figure 3). Because the backwater channel along Configurations 2 and 3 was nearly dry at 5,150 cfs, it is likely that the area remained dry for the remainder of July.

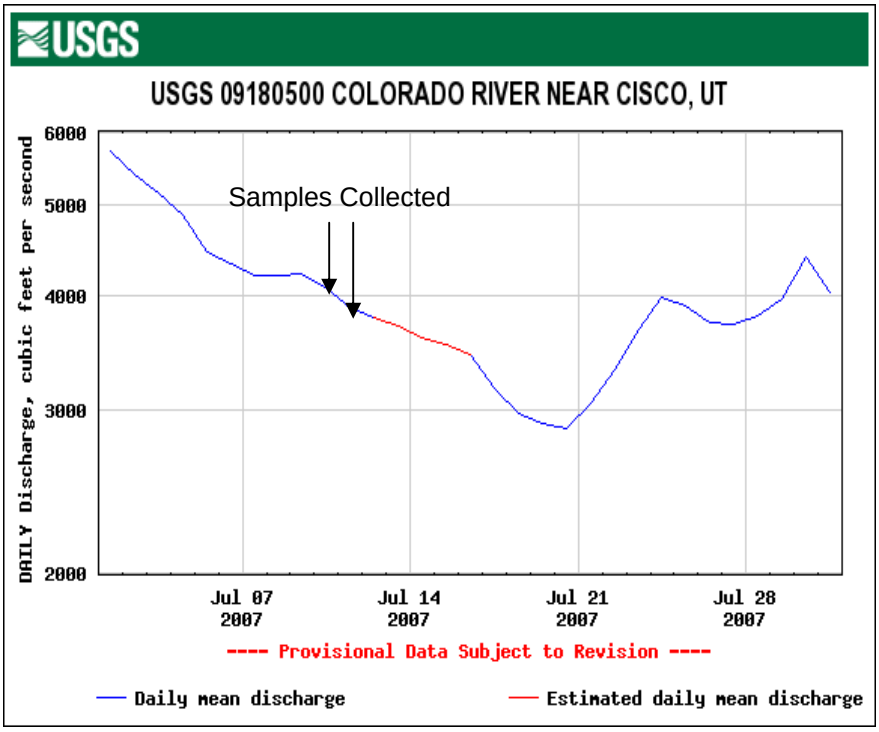

Figure 3. Colorado River Flow (Cisco Gaging Station) During July 2007

4.3 August 2007

Throughout the month of August, Colorado River flow near the site ranged from 2,960 to 5,560 cfs (see Figure 4). The backwater channel adjacent to Configurations 2 and 3 remained dry and full of seasonal vegetation (see Photos 11 to 13). On August 2, the Colorado River flow dropped to 3,260 cfs (see Figure 4) and, as a result, the backwater channel through Configuration 1 was nearly dry, and Configuration 4 was a habitat area. Configuration 1 was also dry on August 22, when the flow was 3,260 cfs (see Photo 14).

Configuration 4 was also considered a habitat area on August 27 when the river flow was 3,360 cfs (see Photos 15 and 16 and Figure 4). Sampling locations 0216 and 0274 were not sampled for the August monthly sampling event until early September 2007.

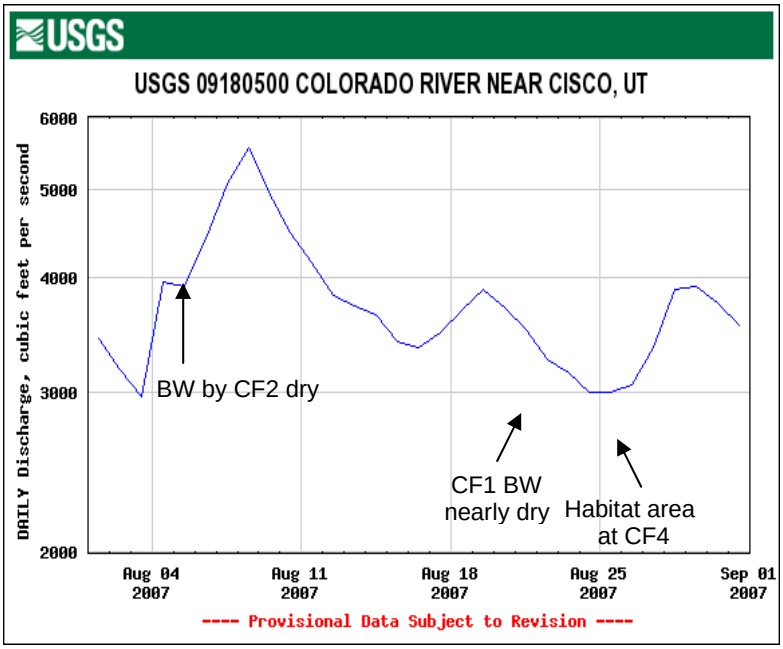

Figure 4. Colorado River Flow (Cisco Gaging Station) During August 2007

4.4 September 2007

The Colorado River flow was variable throughout the month of September. Early in September, the backwater channel adjacent to Configuration 4 alternated from suitable to nonsuitable habitat. On September 4, when the river flow was 3,360 cfs (see Figure 5), the backwater channel near Configuration 4 was connected to the main river channel both up and downstream.

On September 5, the river flow had dropped to 3,300 cfs (see Photos 17 and 18 and Figure 5), and the same backwater channel adjacent to Configuration 4 was closed to the main river channel in the upstream direction. Abundant fish were observed within the channel on September 5. Location 0274 was sampled on September 4 and 5 in order to compare analyte concentrations and ammonia for the two channel conditions. Analyte concentrations were slightly higher and the ammonia concentration nearly doubled (0.11 to 0.20 mg/L) when the backwater channel was not connected on the upstream side (see Attachment A).

Location 0274 was sampled again on September 12, when the river flow was 3,690 cfs (see Figure 5). At this time, the location was fully connected to the main river channel, and the analyte concentration (ammonia 0.12 mg/L) was comparable to the September 4 data (see Attachment A).

Beginning September 17, the Colorado River flow greatly increased from 4,580 to a high of 8,100 cfs (see Figure 5) on September 24. The backwater channel adjacent to Configurations 2 and 3 began to flow. Two surface-water samples were collected during the high flow, one at location 0216 (ammonia 0.25 mg/L) and one at location 0240 (ammonia 0.1 mg/L) (see Attachment A).

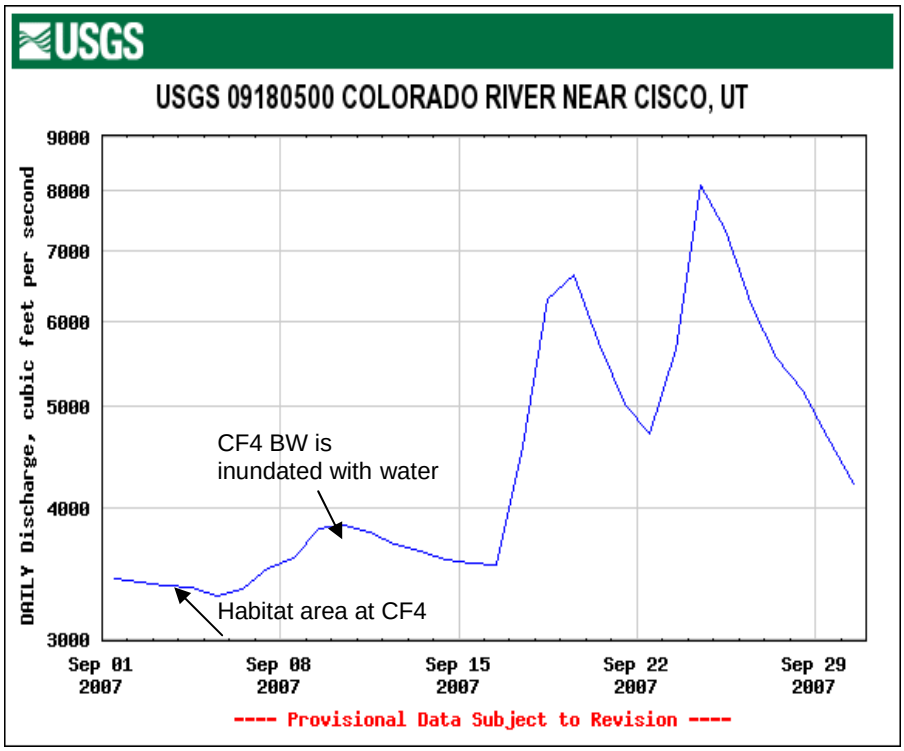

Figure 5. Colorado River Flow (Cisco Gaging Station) During September 2007

5.0 Conclusions and Recommendations

During the 2007 season of biota monitoring, the backwater channel that extends from Configurations 2 to 3 met the definition of a habitat area when river flow ranged from 5,150 to 6,790 cfs. In contrast, the backwater channel adjacent to Configurations 1 and 4 was considered a habitat area when the river flow dropped to below 3,300 cfs. River flows required to create habitat for the Colorado pikeminnow in 2007 are lower than the 4,800 cfs observed at Configurations 2 and 3 in 2006.

The constituent of most concern to the habitat is unionized ammonia because of its bioavailability. Table 2 compares the acute benchmark for the constituents of concern with the highest concentration observed on site during the 2007 biota-monitoring event. The concentration of unionized ammonia varies with water temperature and pH. According to the Site Observational Work Plan for the Moab, Utah, site (DOE 2003), the acute ammonia criteria for the Moab site backwaters is 3 mg/L (see Table 2). All of the concentrations at locations sampled during the 2007 biota-monitoring season were below the criteria, based on temperature and pH. In addition, all of the chloride, copper, selenium, and uranium concentrations were below the applicable acute-aquatic benchmarks (see Table 2). However, manganese and sulfate concentrations in the backwater channel were above acute-benchmark thresholds. Review of data in the Site Observational Work Plan indicates that the background concentrations of these two constituents are higher in the general vicinity. Therefore, observed concentrations of manganese and sulfate are not necessarily related to former industrial activity at the Moab site. The locations with highest concentrations of ammonia and other constituents are typically in shallow water with little or no flow.

Table 2. Benchmark Values vs. Concentrations Measured On Site

Constituent	Benchmark (mg/L) (acute)	Highest concentration observed on site during 2007 biota monitoring (mg/L)	Reference
Ammonia	3	0.27	DOE, 2003
Chloride	860	100	EPA, 1998
Copper	0.012	0.002	DOE, 2003
Manganese	0.01	0.210	DOE, 2003
Selenium	0.005	0.0037	EPA, 2002
Sulfate	100	350	Haines et al., 1994
Uranium	0.046	0.011	Suter and Tsao, 1996

Observations from the 2006 and 2007 biota-monitoring seasons indicate that the main habitat area has migrated southward, as a result of sediment deposition along the river bank from the Moab Wash (just north of the backwater area) during storm and peak runoff events.

Recommendations for the next season of biota monitoring include a collection of parameters in both habitat areas and locations that are likely to become habitat areas with a slight increase in river flow. The frequency of observations and parameters will be dependent on river-flow conditions. An initial-monitoring period will take place in early summer to determine the upper and lower brackets of river flow through the backwater area.

The analytical results indicate that when the Colorado River flow decreases, the analyte concentrations increase in the backwater channel adjacent to the site. However, the highest ammonia concentrations in 2007 were still within the acute-benchmark threshold. When the river flow is high enough to flood the backwater area, analyte concentrations are lower. The results of the 2007 biota-monitoring event indicate that the site contaminants have negligible impact on the adjacent backwaters.

6.0 References

DOE (U.S. Department of Energy), 2003. *Site Observational Work Plan for the Moab, Utah, Site*.

DOE (U.S. Department of Energy), 2005. *Final Environmental Impact Statement for the Moab, Utah, UMTRA Project*.

DOE (U.S. Department of Energy), 2006. *Biota Monitoring Plan Moab Site, Utah*.

EPA (U.S. Environmental Protection Agency), 1998. *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*.

EPA (U.S. Environmental Protection Agency), 2002. *National Recommended Water Quality Criteria*.

Haines, M.L., et. al., 1994. *Fraser River Action Plan: A review of environmental quality criteria and guidelines for priority substances in the Fraser River Basin.*

Suter, G.W., and C.L. Tsao, 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota*.

June 28, 2007
Mean Daily River Flow = 6,790 cfs
First Day of Biota Monitoring

Photo 1. Looking south from the backwater channel adjacent to Configuration 3. On this day, the backwater channel was connected to the river channel by approximately two inches of water.

Photo 2. Looking further south down Configuration 3 backwater channel. The water was approximately three to six inches deep.

Photo 3. The backwater channel between Configurations 2 and 3.

Photo 4. The backwater channel through Configuration 2.
Abundant fish were observed in this portion of the backwater channel.

Photo 5. The confluence of the backwater channel from Configuration 2 to Configuration 1. View is to the south.

Photo 6. Looking south at the backwater channel through Configuration 1. At this time, the channel was open to the river both up and downstream.

July 3, 2007
Mean Daily River Flow = 5,150 cfs

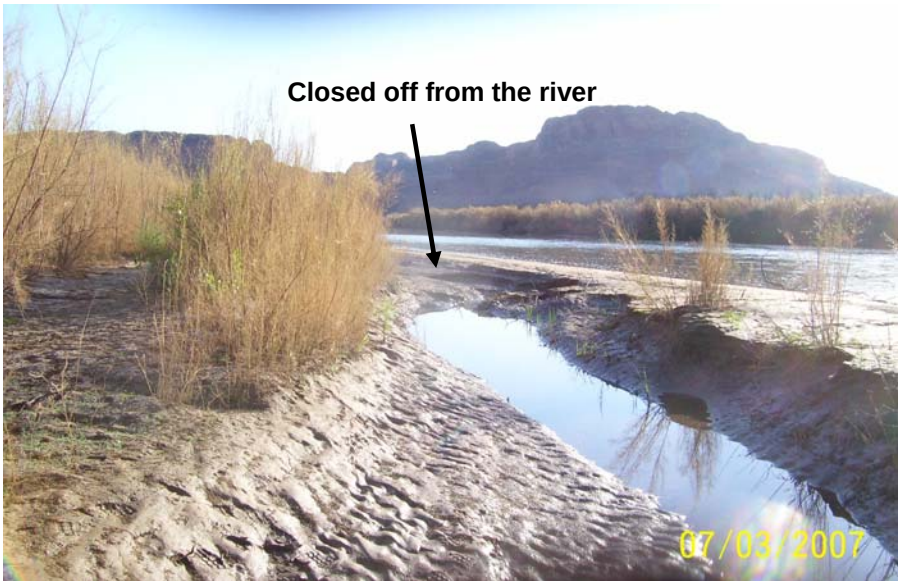

Photo 7. The backwater channel at Configuration 3 is now closed off from the main river channel.

Photo 8. Looking further south from photo 5. This isolated pool of water was located near Configuration 3. Fish were not observed in this location.

Photo 9. Isolated pool of water in between Configurations 2 and 3. View is to the north.

Photo 10. The backwater area of Configuration 2 is nearly dry.

August 7, 2007
Mean Daily River Flow = 5,070 cfs

Photo 11. Looking south at the Configuration 2 backwater channel. It has been dry long enough to establish dense seasonal vegetation.

Photo 12. Backwater channel adjacent to Configuration 1. The channel is fairly narrow, but is connected both up and downstream. View is to the south.

Photo 13. Backwater channel adjacent to Configuration 4. The water is very turbid. View is to the northeast.

August 22, 2007
Mean Daily River Flow = 3,260 cfs

Photo 14. The backwater channel at Configuration 1 is dry. View is to the south.

August 27, 2007
Mean Daily River Flow = 3,360 cfs

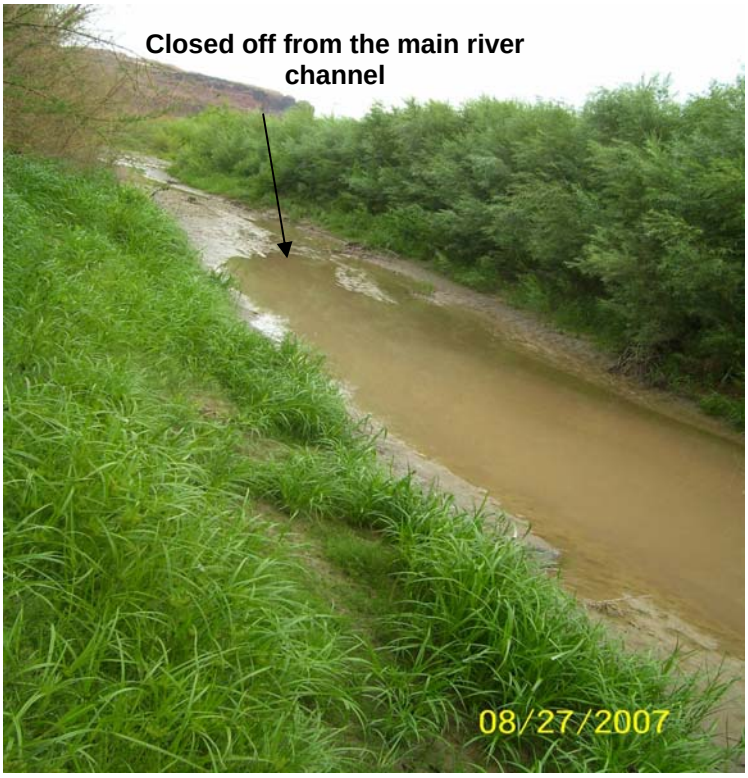

Photo 15. The backwater channel adjacent to Configuration 4 is a habitat area. The upstream side is closed off from the main river channel. View is to the northeast.

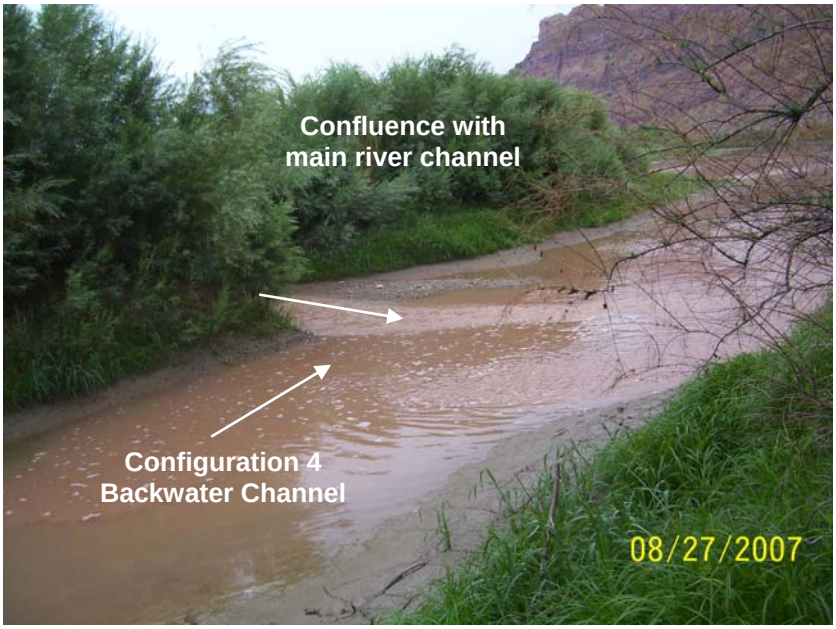

Photo 16. Southern view of the Configuration 4 backwater channel when it intersects the main river channel.

September 5, 2007
Mean Daily River Flow = 3,300 cfs

Photo 17. The Configuration 4 backwater channel is closed off to the main river channel upstream. View is to the northeast.

Photo 18. The Configuration 4 backwater channel is open to the river channel downstream.

Attachment A

Analytical Results of Select Surface Water Sampling Locations (June through September 2007)

Date	Loc.	Type	River Flow (cfs)	Temp (ºC)	Cond (µmhos /cm)	pH S.U.	D.O. mg/L	ORP mV	U mg/L	TDS mg/L	Br mg/L	Cl mg/L	SO_4 mg/L	NH_3-N mg/L	Se (mg/L)	Mn (mg/L)	Cu (µg/L)
06/12/07	0240	B	8,700	21.08	568	8.20	8.28	-214	0.0033	410	0.2	45	140	0.1	.002	.0032	0.55
06/12/07	0236	B	8,700	21.24	579	8.49	9.41	78.7	0.0035	420	0.2	45	150	0.1	.0021	.0048	0.85
06/19/07	0216	B	11,100	20.99	536	8.27	7.84	117	0.0025	340	0.2	35	110	0.1	.0016	.0057	0.36
06/19/07	0274	B	11,100	20.44	829	7.77	7.91	69.3	0.0023	330	0.2	36	110	0.1	.0015	.0025	4.7
06/28/07	0216	NH	N/A	23.23	568	8.43	9.05	-108	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
06/28/07	0258	NH	N/A	25.03	571	8.32	9.41	-127	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
06/28/07	0240	NH	N/A	27.94	571	8.54	10.80	-92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
07/11/07	0274	NH	3,880	27.74	969	8.60	8.91	-300	0.011	660	0.2	82	240	0.19	.0032	0.015	0.44
07/12/07	0216	NH	3,780	N/A	N/A	N/A	N/A	N/A	0.010	680	0.2	84	240	0.27	.0031	0.016	0.44
09/04/07	0274	NH	3,360	26.57	1153	8.16	10.53	-60	0.010	740	0.2	91	310	0.11	.003	0.15	1.5
09/05/07	0274	H	3,300	32.15	1274	8.08	9.41	71	0.0097	770	0.2	100	320	0.20	.003	0.210	2.7
09/12/07	0274	NH	3,690	24.57	1050	7.50	7.50	-63	0.0098	750	0.2	86	290	0.12	.0037	0.041	2
09/24/07	0240	H	8,100	19.81	1117	7.92	7.98	150	0.006	750	0.2	67	350	0.10	.0037	.0036	0.44
09/26/07	0216	NH	6,210	19.36	1393	7.88	7.01	62	0.006	660	0.2	65	280	0.25	.0034	0.054	0.44

H= Habitat, B= Baseline or Background, NH=Not habitat area (open up and downriver)

Loc.= Location, Temp= Temperature, Cond.= Conductivity, D.O.= Dissolved Oxygen, OPR= Oxidation Reduction Potential, U= Uranium, TDS= Total Dissolved Solids, Br= Bromide, Cl= Chloride, SO_4= Sulfate, Se= Selenium, Mn= Manganese, Cu= Copper, N/A= Not applicable